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OPERATIONS RESEARCH, Inc.

SILVER SPRING, MARYLAND

**IDENTIFICATION AND PROMULGATION
OF OBJECTIVES
FOR OAST R&T PROGRAMS**

(TASK 2)

5 March 1975

Contract No. NAS 5-24033, Mod. 22

NASA/GSFC

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IDENTIFICATION AND PROMULGATION OF OBJECTIVES FOR OAST RESEARCH & TECHNOLOGY (R & T) PROGRAMS

INTRODUCTION

1. This is a final task report for NASA/OAST dealing with the identification and promulgation of objectives. It is provided in response to Task II of Contract No. NAS 5-24033, Mod. 22.

PURPOSE

2. The purpose of this report is to set forth overall perspectives and guidelines regarding both the definition and promulgation of objectives within OAST. Emphasis is placed upon (a) the overall practicality of ultimately instituting objective-setting processes within the normal OAST operation, and (b) establishing quantitative measures so that it may be possible to determine the degree to which the objectives have been or are being met. If such quantitative objectives could be defined and promulgated as a working management tool, they would be applied both for space and aeronautics programs.

OVERALL PERSPECTIVE

3. The process of defining and promulgating objectives should not be done in a vacuum, nor should it be merely a "paper exercise" that does not otherwise impact the shape and content of the overall program. Ideally, objectives setting and measurement against these objectives should be an integral and on-going part of the functioning of an organization. Objectives

also should be established at each level within an organization and it should be possible to demonstrate how these objectives contribute to each other through the hierarchy and up to the overall objectives of the organization.

NEED FOR OBJECTIVES

4. The reasons for establishing and promulgating objectives may be summarized briefly as follows:

- a. they aid in focusing the program by defining, at various levels, the overall needs of the organization and the nation at large
- b. they define the desired results but do not inhibit the way in which these results are achieved
- c. they establish a basis for measurement of progress
- d. they tend to lead to a greater degree of success in the program implementation
- e. they serve as a means of unifying understanding and communications at all levels of management.

RELATIONSHIP OF OBJECTIVES TO LONG RANGE PLANNING

5. Objectives are viewed as an essential element in the process of long range planning within OAST. The purposes of the long range planning process should be, as a minimum, to

- a. provide clear guidance as to OAST goals, objectives, and policies
- b. ensure adequate interactive participation, at appropriate levels both in Headquarters and at the Centers, in the definition of programs responsive to the OAST management guidance
- c. facilitate and convey OAST management decisions on program selection, balance, and timing
- d. increase the time and attention applied to the screening, development, and preparation of experimental programs
- e. improve the visibility of OAST programs and their relationship to agency and national needs; and
- f. improve the basis for measurement of progress toward accomplishment of long-term as well as near-term OAST objectives.

EXISTING OBJECTIVES

6. Two distinct sets of objectives have already been defined within OAST, one set at a high level and the other at a low level. The high level objectives are established within the context of the OAST "Matrix." This matrix has three levels dealing with

- a. National needs
- b. National goals
- c. OAST emphasis

The three levels for both aeronautics and space are shown in Tables 1 and 2 respectively.

7. At a lower level, objectives are well documented in the descriptions of the R&T program and specific objectives books.^{1/} These objectives are defined largely at the sub-program level (level III). Appendix A summarizes these objectives for aeronautics, along with the year in which individual objectives are scheduled for achievement. This "bottoms-up" approach is an important aspect of the process of establishing and utilizing objectives.

POTENTIAL NEED FOR ADDITIONAL OR MODIFIED OBJECTIVES

8. Although the above-mentioned "matrix" and "bottoms-up" objectives are significant elements in a program to establish and promulgate objectives within OAST, three potential areas for improvement appear to exist:

- a. there is a gap between the high level matrix objectives and those established within the R&T program and specific objectives books
- b. there is an apparent need to show how sub-program level objectives relate to each other and tie together to satisfy higher level objectives, and
- c. the higher level objectives, in particular, are non-quantitative, making it difficult to determine whether or not, or to what extent, these objectives are being achieved.

^{1/} Aeronautics R&T (Part 1 of 2) and Space and Nuclear R&T (Part 2 of 2), Program and Specific Objectives, FY 1975, March 1974, Office of Aeronautics & Space Technology, NASA, Washington, D. C. 20546

TABLE 1

OAST AERONAUTICS MATRIX

1. R&D Base for the Future

- 1.1 Strong Aero R&D Base
 - 1.1.1 Advanced Aero Technical Knowledge
 - 1.1.2 Advanced Facilities & Equipment
 - 1.1.3 Creative Personnel & Environment

2. Establish Technological Superiority in Military Aeronautics

- 2.1 Enhance Success of Military Aircraft
 - 2.1.1 Supporting Research & Technology
 - 2.1.2 F-15 Support
 - 2.1.3 B-1 Support
 - 2.1.4 Prototype Support
- 2.2 Advanced Technology for Superior Future Aircraft
 - 2.2.1 VTOL Aircraft Technology
 - 2.2.2 Supersonic Aircraft Technology
 - 2.2.3 Hypersonic Aircraft Technology
 - 2.2.4 Highly Maneuverable Aircraft Technology

3. Promote Economic, Community and Human Resources Development

- 3.1 Remove Air Transportation Growth Constraints
 - 3.1.1 Reduce Aircraft Noise
 - 3.1.2 Reduce Terminal Congestion
 - 3.1.3 Reduce Aircraft Air Pollution
 - 3.1.4 Improve Low-Density Short-Haul Economics
- 3.2 Efficient High-Density Short-Haul Systems
 - 3.2.1 Short-Haul Operating Systems Technology
 - 3.2.2 Short Haul Transport Technology
- 3.3 U.S. Long Haul Aircraft Leadership
 - 3.3.1 Advanced Subsonic Transport Technology
 - 3.3.2 Advanced Supersonic Transport Technology
 - 3.3.3 Terminal Configured Vehicle Technology
- 3.4 Aviation Safety and Utility
 - 3.4.1 Aviation Safety
 - 3.4.2 General Aviation

TABLE 2

OAST SPACE & NUCLEAR MATRIX

1. Gain Fundamental Scientific Knowledge

- 1.1 Engineering Science & Innovation
 - 1.1.1 Basic Research
 - 1.1.2 Innovative Technology
- 1.2 Deep Space Exploration Systems
 - 1.2.1 S/C & Entry Systems Technology
 - 1.2.2 High Energy Propulsion Technology

2. Routine & Economic Space Transportation & Facilities

- 2.1 Low Cost Technology for Exploitation of Space
 - 2.1.1 Shuttle Technology
 - 2.1.2 Lower Cost & High Performance Effective Systems
 - 2.1.3 Shuttle Exploitation Technology
 - 2.1.4 User Interactive Information Systems & Monitoring

3. Expand Practical Application of Space Technology

- 3.1 Technology for Civil Needs
 - 3.1.1 Solar Energy
 - 3.1.2 Energy Conversion & Conservation
 - 3.1.3 Civil Systems Technology
- 3.2 Technology for Military Needs
 - 3.2.1 DOD Support

RECOMMENDATIONS

Structure and Analysis of Objectives

9. It is recommended that OAST consider establishing and promulgating additional objectives that fulfill the need suggested above. As a point of departure, it is suggested that OAST further consider the very preliminary example of a set of objectives that might fit logically within the existing objectives' structure, as shown in Table 3. These objectives have the following main characteristics:

- a. they are largely quantitative
- b. they are associated with a set of intermediate level goals
- c. they fit logically between the existing sets of high and low level objectives and program areas.

10. It is recommended that OAST perform a "time-line" analysis at the low level objectives (a preliminary base-line for such an analysis is provided in Appendix A) that shows explicitly

- a. how the objectives array themselves over time
- b. the extent to which the given 1975 objectives have been achieved, and
- c. how sub-program level objectives relate to one another and may be aggregated and related to higher level objectives.

11. It is recommended that the results of the above type of analysis be provided to management at the various Centers so that they

- a. may see possible ways of improving the process of setting objectives, and
- b. may become more deeply involved and perhaps committed to the use of objectives as an on-going part of their management and R&T functions.

12. It is recommended that a series of workshops be established, involving management at both Headquarters and the Centers, to assist in the process of identifying and promulgating objectives and relating them to long range planning within OAST.

<u>PROGRAM AREAS</u>		<u>OBJECTIVES FOR GOAL I</u>
<u>GOAL I — IMPROVE PRODUCTIVITY</u>		
Aircraft Costs	Manufacturing, Operating, Maintenance Costs, . . .	• Demonstrate reduction in cost/seat-mile of ___ % (— by class/type of A/C, by year, etc.)
Aircraft Performance	Weight, Strength, Aerodynamics, Propulsion, . . .	• Demonstrate reduction in cost/cargo-ton mile of ___ %
Operations Efficiency	A/C Control, Guidance, Avionics, Airfields, . . .	• Achieve increase in Support/test efficiency of ___ %
Support & Test Facilities	Wind Tunnels, Test Equipment, Computers, . . .	• Obtain increase in engine efficiency of ___ %
Energy	Fuel efficiency, engine efficiency, . . .	• Increase cost recoupment ___%/yr over next ___ years
:		
<u>GOAL II — REDUCE ENVIRONMENTAL IMPACT</u>		<u>OBJECTIVES FOR GOAL II</u>
Noise	- etc -	• Decrease engine noise output by ___ % (— by type engine, year, etc.)
Pollution		• Decrease engine pollutant output by ___ %
Wake Vortex		
General Atmosphere		
:		
<u>GOAL III — SUPPORT STANDARDS & SAFETY IMPROVEMENT</u>		<u>OBJECTIVES FOR GOAL III</u>
Requirements		• Produce technical data to support noise standard ___ by ___.
Program Design	- etc -	• Produce technical data to support safety regulation ___ by ___.
Dissemination		
:		
<u>GOAL IV — MAINTAIN STRONG TECHNOLOGY DATA BASE/TRANSFER</u>		<u>OBJECTIVES FOR GOAL IV</u>
Data Base Preparation		• Improve utilization of data by ___%/year
Information Dissemination	- etc -	• Identify and target for industry transfer — major tech. achievements over next 10 years
Information Utilization & Impact		• Decrease time by ___% for transfer from laboratory to marketplace for major tech. achievements
Technology Transfer		
:		
<u>GOAL V — ENHANCE SUPERIORITY IN MILITARY AERONAUTICS</u>		<u>OBJECTIVES FOR GOAL V</u>
Specific Program Support		• Identify and target for military transfer ___ major tech. achievements over next 10 years
Data & Technology Transfer	- etc -	• Increase cost recoupment ___%/yr over next ___ years
:		
<u>GOAL VI — — —</u>		

TABLE 3

POTENTIAL STRUCTURE FOR ADDITIONAL OBJECTIVES DEFINITION

Follow-up Action Plan

13. It is recommended that the following timetable be considered for follow-up actions relative to objectives within OAST. This timetable is prepared without knowledge of other potentially conflicting time and program commitments within OAST.

<u>Activity</u>	<u>Suggested Timetable</u>
Initial presentation of concepts for new objectives to OAST top management	end March 1975
Time-line analysis of existing low-level goals	April - June 1975
Initial workshop/discussion of new objectives with middle management	end April 1975
Modification/formulation of new objectives and presentation to OAST top management	May 1975 - August 1975
Plan for introduction of new objectives into planning, budgeting and overall management processes	September 1975

APPENDIX A

R & T SUB-PROGRAM (LEVEL III) OBJECTIVES
SHOWN OVER TIME

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Comments

1980

1979

1978

1977

1976

1975

**High Temperature
Engine Materials**

Identify stable mod-
ifications of II b-11
alloy.

Evaluate II b-7 alloy
in full-scale disk
forms.

Demonstrate ade-
quate transverse
ductility, shear
strength & fatigue
properties for gamma/
gamma prime-delta
alloy.

Select 3 composition/
processing combina-
tions for gamma/
gamma prime-delta
to be fully evaluated
for mechanical prop-
erties.

Potential of combin-
ing dispersion
strengthening &
gamma prime
strengthening for a
long range advanced
turbine blade
material.

Demonstrate a coating
for ODS NiCrAl with
500 hr oxidation pro-
tection.

Determine thermal
fatigue resistance
of refractory wire-
reinforced superalloy
matrix composites at
temperatures up to
2000° F.

Select one method
for improving tough-
ness of ceramics &
initiate intensive
development of that
method.

Demonstrate a coat-
ing for ODS NiCrAl
with 1000 hour
oxidation protec-
tion at 2000° F
(1094° C) & 1000
hr hot corrosion
protection at 1600°
F (870° C) in Mach
1 tests.

A search of technology for
new classes of superior
materials & processes for
high temperature components
of average turbine engines
to be vigorously pursued to
meet needs of engines to be
operational in the 1980's.

**Fatigue and Fracture
Behavior of Mater-
ials for Improved
Life Prediction**

Proposal to ASTM
for modification of
the current ASTM
E399K_{1C} standard
test method.

Verify a method for
estimating the par-
titioned strainrange-
life relationship for
elevated temperature
low-cycle fatigue
specimens from con-
ventional tensile &

Proposal to ASTM
for plane strain
screening test.

Identify importance
of surface-enviro-
ment interactions &
establish proce-
dures for predicting
fatigue life & frac-
ture of materials
exposed to aggres-
sive environments.

Develop low-cost
fracture toughness
mixed mode screen-
ing test method.
Verify a life predic-
tion method based
on the concept of
strainrange parti-
tioning that is appli-
cable to components
subject to creep-
fatigue such as tur-
bine vanes, blades,

To understand fatigue and
fracture behavior of both
metal and composite mater-
ials to develop life predic-
tion procedures and frac-
ture control technology.

Safer, Lightweight Airframe Materials

Work directed at synthesizing new and improved polymers, composites & lightweight metals to provide greater passenger safety, particularly in case of crash fires.

Demonstrate low temperature curing structural adhesives.

Establish technology for use of metal matrix composites.

Establish methods for determining defects & repair procedures for composite materials & demonstrate capability & reliability of repaired components.

Develop boron aluminum engine fan blades having high resistance to foreign object impact damage.

Synthesize highly processable polyamides, polyphenyl quinoxaline matrix materials for engine fan blades.

Demonstrate processible polyamides which do not exhibit thermoplasticity at 600° F.

Determine feasibility of polyamide-ester polymers as low temperature curing adhesives.

Evaluate toxicity of gaseous thermal degradation products of neat polyphosphazene polymers.

Complete synthesis of colorless & transparent polycarbonates.

Demonstrate control of the thermoplasticity of polyamides suitable for adhesives.

Demonstrate with laboratory specimens the potential of boron aluminum composites using large diameter boron ductile matrix.

Advanced Structural Concepts

Development of efficient structural components for flight testing to Mach 8 for hypersonic aircraft.

Verify concepts for actively cooled wing structures for a hypersonic aircraft that will provide 15% weight savings over an uncooled structure.

Develop an analysis procedure for complex aircraft structures under dynamic loading conditions that can be used in crash survivability analyses.

Explore innovative concepts into new structural configurations.

Confirm feasibility of an optimized hot wing structure for a hypersonic aircraft by high temperature laboratory structural tests.

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Loads, Aeroelasticity, and Structural Dynamics

Assess various active & passive aircraft control systems.

Complete subsonic flutter prediction capability for NASTRAN.

Complete supersonic flutter capability.

Develop a method to account for boundary layer thickness on flutter of panels & include computer program.

Determine methods for predicting oscillating loads in turbulent flows.

Develop nonlinear unsteady transonic aerodynamic theory for wing & control surfaces to within 10% accuracy.

Improve in technology in areas of loads, aeroelasticity & structural dynamics to increase aircraft performance, extend service life, aircraft safety & ride quality.

Structural Integrity

Prediction of residual strength of reinforced steel structures containing flaws.

Develop nonlinear fracture methods applicable to ductile engineering materials.

Establish cumulative damage law reducing error in fatigue life prediction.

Improve procedures for predicting rate of growth of cracks & the number of cycles to failure of cracked structures.

Verify techniques allowing time compression of life cycle testing of hot structures - 1 min of test will simulate 1 hr of flight.

Objective to eliminate structural failures when operating in the specified environment and loading spectra.

A-3

Composite Structures

Aeronautics Structures & Dynamics Program

Demonstrate composite primary structure in CH-54B helicopter 15% weight saving using boron-epoxy composite in aft fuselage.

L-1011 Airline Trans 27% weight saving with Kevlar-49-epoxy composite in fuselage.

L-1011 - A 15 to 20% weight saving with hybrid graphite-epoxy composite in ailerons.

DC-10 Airline Trans 45% weight saving using graphite-epoxy composite in rudder assembly.

Analysis and Design

Methods

Aeronautics Structures & Dynamics Program

Decrease cost of computer usage in resizing techniques behavior of structures (IPAD, NASTRAN).

Document new versions of SRA shell of revolution programs & STAGS general shell program.

Aiming to increase accuracy of theoretical methods of static & dynamic analysis & design to improve structural efficiency of aircraft.

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Predict complete aerodynamic characteristics of 3-dimensional aircraft configurations.
Eliminate wake vortices, buffet and airframe noises.
Improve wind tunnel simulation.
Efficient technology for airfoil & configuration designs.
Prediction techniques for vehicle's high angle of attack flight characteristics.

Funding requirements estimated through Fiscal Year 1979 for advance understanding & predictive capability of aerodynamic phenomena in early design stages of advanced aircraft.

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Prediction of Aerodynamic Phenomena

Aerodynamics & Vehicle Systems Division

Provide computer code to simulate steady inviscid transonic flow about wing & wing-body combinations.

Extend capability of calculating inviscid flow-field over wing-body configurations at transonic speeds.

Obtain empirical turbulence models of attached and separated boundary layer flow over a wide range of speeds, altitudes and pressure distributions.

Develop basic numerical algorithms and procedures to increase accuracy of computing flow fields. Develop & improve languages & compilers suitable for ILLIAC IV & STAR advanced computers.

Incorporate improved turbulence models into aerodynamic flow equations.

Development of capability to predict aerodynamic characteristics of complex three-dimensional aircraft configurations to a degree that preliminary design concepts can be evaluated & screened with reduced wind tunnel test time and cost.

Minimization of Undesirable Aerodynamic Phenomena

Aerodynamics & Vehicle Systems Division

Begin flight test evaluation and demonstration of vortex alleviation devices.

Identify individual airframe noise source contributions on jet transport.

Develop analytical prediction techniques for radiated aerodynamic noise from discrete sources.

Develop capability to predict buffet intensity of combat aircraft throughout maneuver envelope.

Initiate final flight demonstration with most effective vortex alleviation devices on wide-body jet transport.

Aerodynamic design techniques to permit reduction in 3-5 mile landing separation distance demonstrated.

Determine design principles to reduce aircraft noise by 10 dB per decade.

Study of aerodynamic factors that control the generation & magnitude of wake vortex, noise and buffet phenomena to reduce detrimental effects.

Airfoil & Configuration Aerodynamics

Aerodynamics & Vehicle Systems Division

Upgrade facilities for high Reynolds number, high angle of attack, & improved flow quality operation.

Provide low speed automated airfoil design program, including viscous effects, with performance and geometric con-

Provide high speed automated airfoil design.

Urgently needed development of new airfoils for attaining higher aerodynamic performance efficiencies.

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**Experimental Methods
& Facilities
Technology**

**Aerodynamics &
Vehicle Systems
Division**

Using pilot facility
determine capa-
bilities & limita-
tions of cryogenic
tunnel concept.
Establish flight
test capability
for large-scale
RPRV's.

Develop technology
for a "quiet" super-
sonic tunnel.
Minimize transonic
wall interference
through improved
wall design & correc-
tion methods.
Provide operational
Laser Doppler
Velocimeter systems
offering non-disturb-
ing velocity measure-
ment capability.

**Stall/Spin - High
Angle of Attack**

**Aerodynamics &
Vehicle Systems
Division**

Complete flight simu-
lator definition &
evaluation of critical
flight dynamics
parameters.
Establish guidelines
for design of spin-
resistant airplanes.

Definition of criteria for
improved high angle of
attack maneuvering capa-
bility.

Flight Dynamics

**Aerodynamics &
Vehicle Systems
Division**

Develop autopilot
& flight director
modes for powered
lift short haul
transport.

Develop & apply
pilot vehicle models
to the prediction of
the effects of ride
qualities & handling
qualities.

Develop computer-
aided design methods
to determine control
system design
parameters.

Design information and new
criteria required to accu-
rately define the proper
vehicle response character-
istics of stability & control
vital to safe & efficient
operation of all aircraft.

Investigation of scale tunnel
& measurement parameters
that affect the accuracy of
predicting flight performance
from wind tunnel tests.

1975

1976

1977

1978

1979

1980

Comments

Low-Speed Vehicle Systems

General Aviation Aerodynamic Technology

Flight demonstration of low-speed airfoils.

Definition design criteria, test & evaluation for aircraft that will not spin unintentionally.

Low-noise propellers design criteria.

Advanced Rotorcraft Aerodynamic Technology

Rotor-tip vortices experimental evaluations.

CH-53 helicopter acoustic/motion environment for short-haul.

Controllable-twist rotor concept.

Full-scale static tests.

Variable-geometry rotor concept.

Non-linear control concept.

Design prediction methods for rotor-blade & control system dynamics.

Demonstrate technology for tilt-rotor control systems suitability.

Advanced VTOL Aircraft Aerodynamic Technology

Evaluate VTOL aerodynamic performance, stability & control of XFV-12A ejector wing configuration.

Lift-fan VTOL transport configurations in terminal area operation.

Static tests of lift/cruise fan nacelles and thrust vectoring vehicle control systems for acceptable interactions of the exhaust flow with the aircraft, ground & airstream.

Advanced high pressure hypermixing VTOL ejector concepts in forward flight transition engines.

Applying basic fluid mechanic phenomena to optimize jet interference effects during transition flight.

Simulator investigations for acceptable approach parameters for manual control during takeoff, approach & landing on sea control ships.

Verify design criteria for land-based VTOL aircraft control systems to handle system failures & refine hover control system.

Devise satisfactory theoretical methods to predict induced flow for VTOL podded configurations.

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Low-Speed Vehicle
Systems

Advanced Powered-
Lift Aircraft
Aerodynamic
Technology

Verify advanced systems with improved nozzles & augmented jet flap designs.

Provide information to avoid or reduce by half cruise drag penalties of upper surface blowing systems.

Verify aero/acoustic control characteristics of powered-lift transport configurations models with lobe-nozzle USB concepts.

Evaluate a hinged plate spoiler system of a low-wing loading non-powered-lift STOL transport.

Complete small-scale study to develop cruise augmentor technology.

Verify aero/acoustic control characteristics of powered-lift transport configurations models with lobe-nozzle AW concepts.

Handling quality investigations of powered-lift STOL/RTOL transports using simulators (FSAA), for solving problems of flight path control & transition from cruise to approach.

Establish handling qualities & performance certification standards for future STOL/RTOL powered-lift civil transports & development of safe flight procedures for demonstrating compliance with the criteria.

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High-Speed Vehicle Systems

Medium & Long Haul Cruise Aircraft Aerodynamic Technology

Investigations to improve supercritical aerodynamics, transonic airframe/pylon/nacelle interference and update analytical prediction methods for optimizing transport configuration design.

Investigations of wing-trailing and leading-edge controls.

Establish powered AFT wind tunnel model designs.

Aerodynamic performance advantage of oblique wing concept transport design.

Define subsonic transport configurations with varied design parameters.

Evaluate aerodynamic control characteristics of subsonic transport configuration optimized for energy requirements. Integrated computational system for optimization of design parameters & assessment of generalized high supersonic speed aircraft configuration concepts.

Combat Vehicle & Missile Aerodynamic Technology

Thrust-vectoring flight tests.

High lift devices to delay flow separation limiting angles of attack values to determine effects of variations in wing geometry.

Analytical & experimental investigations on airframe propulsion system integration.

Limited evaluation of H AAT & AFTI concepts.

Joint WK and NASA effort evaluated of VIFF capability.

Conduct differential maneuvering simulator experiments to evaluate value of varied parameters in one-to-one simulated air combat.

Primary efforts completed.

Provide aerodynamic data base for increased efficiency in flying at greater altitudes.

Verification of advanced technology benefits.

Investigate the oblique wing for transport application.

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Establish new aerodynamic technology for advanced missiles with increased mission performance.

Achieve overall aerodynamic characteristics in configuration designs offering higher lift-drag ratios for reduced fuel requirements.

High-Speed Vehicle Systems

Combat Vehicle & Missile Aerodynamic Technology (Cont'd)

Define missile design concepts with less reliance on electronics & with reduced control actuator requirements.

Increase from 15 to 40 g's the potential maneuver capability for air-to-air missiles.

Increase aerodynamic L/D efficiency and range for standoff missiles.

Hypersonic Aircraft Aerodynamic Technology

Evaluate candidate substitute gases for simulating engine exhaust flows & methods to include internal shocks.

Initiate studies of HIRA, MACH 3 to 6 hydrogen fueled & actively cooled transports.

Aerodynamics & Vehicle Systems

Definition of aerodynamic forces, moments, loads, flight-path departure/spin-entry & flutter characteristics, flying qualities, inlet drag, nozzle performance & propulsion system installation effects to support development of F-15, YF-16, YF-17, XTV-12A, A-10, B-1, & AMST aircraft systems.

Contractor studies of parametric & wind tunnel configurations to provide data for simulator evaluation.

Generate & validate technology of integrating propulsion system with the airframe.

Determine by FY 1982 potential of airframe active cooling for application to operational aircraft.

Define by FY 1982 a high-speed research airplane (HSRA) capable of meeting NASA & USAF flight research requirements.

DOD requests NASA assistance to perform tests in support of military development programs.

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Propulsion Noise
Reduction

Demonstrated J-85 noise suppression using a retractable nozzle in F-106 flight lists. Exploratory studies of noise propagation & atmospheric attenuation using an instrumented tower. Complete flight test noise measurements on supercritical propeller design.	Obtain analytical data for noise generating mechanisms in simple jet flows to guide technology for reducing jet noise generation for subsonic jets. Conduct wind tunnel noise tests on variable pitch Q-Fan for general aviation aircraft.	Obtain analytical data for noise generating mechanisms in simple jet flows to guide technology for reducing jet noise generation for supersonic jets. Establish practical techniques for controlling core noise sources & optimize acoustic designs of propulsion systems.	R&T on propulsion noise reduction, noise footprint reduction & exhaust emission pollution necessary. To provide data and a technology base for reducing aircraft propulsion generated noise with minimum weight, performance & economic penalties.
Reduce by 60% thrust loss penalty to 1% per 5 EPNdB due to supersonic jet noise suppression devices. Determine basic effects of forward velocity on jet noise generation & propagation. Achieve reduction in fan-stage source noise by means of aeroacoustic design. Improve acoustic suppression materials & technology to achieve 50% reduction in installation weight attributable to such suppression treatment. Demonstrate practical high subsonic threat Mach number inlet design concepts. Determine noise generation effects due to internal & external surfaces guiding on control jet flows. Establish effects of random characteristics of the atmosphere on propagation of aircraft noise into airport community.			

High-Speed Vehicle Systems

Noise Footprint Prediction

Construct interim computer program for noise contour predictions.
Establish basic analytical models for key technical areas in source noise prediction, noise transmission, & community impact.

Improve data base capabilities of the interim program to predict noise contours within $\pm 40\%$ accuracy (± 1.5 dB accuracy of noise contour).

Establish a prediction & design capability to compute noise contours for current & proposed aircraft systems based on analytical modeling of individual component noise sources.

Need for an accurate noise footprint prediction capability to meet demands of recent noise regulations.

Exhaust Emission Pollution Reduction

Evaluate selected combustor concepts to reduce exhaust emission pollutants of commercial jet aircraft engines.
Establish & demonstrate technology necessary to reduce general aviation intermittent combustion engine exhaust levels with minimum adverse effects on cost, weight, & fuel economy.

Evaluate selected combustor concepts to reduce exhaust emission pollutants of general aviation turbojet, -fan, and -prop engines.

Establish minimum levels of exhaust emission pollutants that may be practically achievable in advanced aircraft gas turbine engines.

To meet the EPA 1979 standards, a reduction in engine exhaust emission pollutants to approximately 25% of the current engine levels is required.

Interactions of Exhaust Emission with Atmosphere

Installation of instrument packages for pollution monitoring on two 747 airlines.

Measure & report kinetic rate constants for selected reactions identified in CIAP & in-house modeling studies.

Determine aerothermochemical processes involved in exhaust gases & particulates mixing with the atmosphere.

Document & analyze effect of aircraft exhaust emission pollutants on the level & distribution of minor atmospheric constituents in the upper troposphere & lower stratosphere.

A worldwide measurement system is needed to monitor the character & distribution of the minor atmospheric constituents within the altitude & geographic corridors that current & future aircraft will operate in.

ORIGINAL PAGE IS OF POOR QUALITY

Minimize future development effort and cost of advanced aircraft by generating design methodology for inlets and nozzles to achieve higher performance in stability and operating range.

Establish criteria for design and installation of subsonic transport nacelles at near sonic flight speeds. Synthesize a first generation computer design program for defining optimum axisymmetric inlets at zero angle of attack. Provide consistent set of experimental supersonic inlet design-trade data for a matrix of axisymmetric & two-dimensional inlets covering a range of internal compression.

Generate a three-dimensional viscous analysis of flow in subsonic diffusers with arbitrary cross-sectional transitioning & offset blends utilizing the parameterized Navier-Stokes equations.

Generate a computer analysis to calculate the flow in an axisymmetric supersonic diffuser at angle of attack combining a three-dimensional method of characteristics solution & an interacting viscous analysis.

Establish criteria for predicting Reynold's number effects on boattail drag.

Advanced technology applied to fans and compressors to reduce engine weight needed to benefit military aircraft as well as CTOL and V/STOL commercial aircraft.

Generate & evaluate prediction of aeroelastic instabilities of fan and compressor blades and extending flutter boundaries.

Evaluate methods of calculating three-dimensional flow fields through a compressor. Demonstrate technology for achieving 10:1 pressure ratio in a small single stage centrifugal compressor & 18:1 pressure ratio in two stages with an efficiency greater than 80%. Evaluate core turbine cooling technology for average inlet temperatures on blade end walls.

Evaluate causes & corrective measures for reduction of non-uniform flow distributions at the compressor discharge. Predicting sensitivity to inlet flow distortions. Prediction of aeroelastic instabilities of fan & compressor blades. Determine effect of film-cooling holes on turbine airfoil low cycle fatigue life. Develop two-dimensional unsteady analytical flow methods for predicting aerodynamic forces associated with blade flutter.

Develop two-dimensional procedures for calculating flow conditions within transonic blade rows.

Fans, Compressors and Turbines

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Combustors and
Augmentation
Systems
Propulsion
Components
Branch

Drive System
Mechanical
Components

Develop combustors and
thrust augmentors to
provide lighter weight,
wider operating range and
improved fuel consumption.

Improved bearings, seals,
and lubricants are essential
in advanced aircraft engines
which operate at higher
rotative speeds with increased
pressure ratios and at higher
temperatures.

Demonstrate
advanced
combustor
concepts.

Feasibility of using
advanced combustion
concepts to improve
current technology.

Determine stability
of selected combustor
concepts for small
gas turbine shaft
power engines.

Demonstrate tech-
nology for increasing
life of rolling element
bearings & engine
seals.

Demonstrate feasi-
bility of a rolling
element gear trans-
mission concept for
high speed ratio
reduction.

Demonstrate tech-
nology for increasing
life & load carrying
capacities of gears.

Demonstrate tech-
nology for safely
operating multi-mass
turbine engine rotors
& power transmission
shafting for heli-
copters & STOL-type
aircraft.

ORIGINAL PAGE IS
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**Air Breathing
Engine Systems
Research and
Technology**

**Propulsion System
Dynamic Behavior
and Control**

Prediction capability of propulsion system dynamic behavior required to obtain control systems which are less costly to develop and produce.

Develop methodology to predict inlet engine compatibility turbofan.

Determine dynamic nature of transient disturbances from an afterburning turbojet engine & component interactions.

Determine dynamic nature of transient disturbances from an afterburning turbojet engine & component interactions.

Determine dynamic nature of transient disturbances from an afterburning turbojet engine & component interactions.

Develop methodology to predict inlet engine compatibility turbojet.

Determine dynamic nature of transient disturbances from an afterburning turbojet engine & component interactions.

USAF/NASA demonstration of an advanced integrated propulsion control system installed in an F-111 aircraft.

**Propulsion System
Integration**

Sensitivity of STOL and VTOL propulsion systems to interactions and distortions must be evaluated because of pronounced effects on noise performance and stability.

Determine efficiency of fans & ejectors on lift thrusters for VTOL aircraft systems.

Determine effects of flow distortions on compressor & overall engine performance & stability margins.

Determine engine/nacelle/airplane installation effects.

**Low Cost Engine
System Technology**

Technology research for low-cost engines would decrease cost of aircraft & permit the benefits of gas turbine engines to be extended to a larger segment of general aviation.

Techniques for designing compressor blades more compatible with airfoil dimensions attainable in low cost investment costing technique.

Develop basic methods for incorporating coined sheet metal blades into a compressor assembly & hollow sheet metal blades into a fan assembly.

**Advanced System
Concepts**

Investigate feasibility of new propulsion system concepts to provide increased performance or lower fuel consumption.

Determine impact of cryogenic hydrogen & methane fuels on advanced aircraft engine & propulsion system designs & engine component research requirements to accommodate use of fuels.

ORIGINAL PAGE IS
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**Air Breathing
Engine Systems
Research and
Technology**

**Hypersonic
Propulsion**

**Aeronautics Avionics
Research and
Technology**

**Advanced Avionic
System Concepts**

1975

1976

1977

1978

1979

1980

Comments

Demonstration of hypersonic propulsion system concept with reduced engine cooling requirements.

Determination of scramjet propulsion system concepts with static thrust potential.

Development of hypersonic flow prediction techniques.

Establish procedures for predicting internal shock-boundary layer interaction in hypersonic inlets & diffusers & combustors needed for efficient & stable scramjet engine system designs.

Establish technology for hydrogen fueled propulsion systems integrated with the vehicle aerodynamic & structural system for sustained hypersonic flight.

Complete flight tests of initial 4-D guidance system.

Complete design of full-flight envelope autopilot for augmentor wing aircraft.

Complete preliminary design of full-flight envelope autopilot for tilt rotor aircraft.

Complete analytical studies of receiver configuration for VLF navigation.

Complete piloted simulation of fuel-optimal 4-D guidance system for STOL aircraft.

Complete general aviation/ATC systems operational analysis.

Complete investigation of general aviation flight control techniques.

Complete flight tests of fuel-optimal 4-D guidance system for STOL aircraft.

Start flight tests of full-flight envelope autopilot on augmentor wing aircraft.

Demonstrate through flight tests an experimental navigation system for general aviation aircraft based on VLF navigation technology.

To obtain improved avionics systems providing aircraft with the maneuverability for operation in the projected air traffic control environment for the 1980's.

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1975

Start flight tests of a split surface stability augmentation system in a Beech-99 general aviation airplane.
Complete analytical studies of individual microstrip antennas.

1976

Complete experimental evaluation of microstrip antennas in conformal arrays.
Evaluate the handling & ride quality improvements of a split surface stability augmentation system.

1977

Produce a practical digital receiver design which differentiates between the direct & indirect signal in the presence of multipath interference & thus reduces the error probability.

1978

1979

1980

Comments

Instrumentation, data processing, communications, control and display improvements to be investigated in avionics systems.

Complete design of two different fault-tolerant computer organization concepts.
Complete derivation of theoretical design criteria for fault-tolerant computer systems.
Complete derivation of techniques for assessing reliability & fault-tolerance of system designs methodology.
Complete synthesis of a fault-tolerant computer & validation of reliability assessment technology.

To establish a technology base which supports the flight application of economically-viable, fail-safe digital computer systems for civil aircraft.

Demonstrate operational three-axis, low-velocity airspeed sensor with accuracies of 2'/sec or better.
Flight test of acoustic altimeter brass-board complete.

Complete flight tests of laser gyro strap down navigation system.
Complete ground & flight tests of automatic & manual display concepts.
Start flight tests of trilateration landing guidance system.
Begin flight tests of learning control algorithms.

Implement & flight-validate an integrated multi-function display including automatic system failure monitoring.
Mechanize & flight-test an audio inertial navigator & stabilization system with 20,000 hr life, 1 mm/hr accuracy & a production cost under 50K.

Objective to generate the advanced avionics technology required for reliable & cost-effective automated flight, with primary emphasis on take-off & landing of future helicopters & VTOL aircraft by FY 1981.

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A description to define and quantify those properties of aircraft noise exposure to reduce general public hostility to air transportation systems.

Develop a model for reliable prediction of responses of people.

Study effects of low frequency noise characteristics generated by present and future aircraft on auditory and non-auditory responses of people.

Evaluate effects of aircraft operation on sleep and performance of people.

Quantify effects of background environmental noise exposure on human response to aircraft generated noise. Ascertain effects of aircraft noise on man's speech production/perception.

Determine effects of multi-event noise exposure characteristics on human response to aircraft operations.

Devise methodologies for laboratory and field studies of human response to aircraft operations.

To define and quantify those properties of motion and vibration that determine ride quality and passenger acceptance of air transportation systems.

Develop a model for reliable prediction of ride quality and passenger acceptance of advanced transport aircraft.

Examine the effects of aircraft maneuvers on passenger acceptance.

Complete research on effects of noise and vibration on human response.

Establish methodology for studies of passenger response to aircraft motion and vibration.

Determine effects of multi-axis motion and vibration on human response.

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Man-Vehicle
Research and
Technology

Flight Management
of Automated
Cockpit Systems

Define the probable ATC
environment of the 1980's-
1990's.

Verify through flight
test, the avionics
and human compon-
ents of the system.

Acquire flight sys-
tems and avionics
for preparation of
representative
1980's and 1990's
cockpit configura-
tions.

Complete evaluation
through mission
simulation of control
and display alterna-
tives, flight proce-
dures and crew
roles.

Identify deficiencies
in existing cockpit
systems.

Define and develop
tools (oculometer)
for quantitative de-
termination of crew/
pilot workload.

Define and evaluate
solution concepts
including cockpit
configurations, crew
roles, flight proce-
dures and control,
and display charac-
teristics.

Complete full mis-
sion/aircraft/air
traffic control
simulation capa-
bility.

Flight
Simulation
Technology

Identify constraints
limiting usage of
simulators. De-
fine and implement
research program
to remove con-
straints.

Develop and apply
stable integration
algorithms for non-
linear equations of
motion to permit a
50% reduction in
required iteration
rates for digital
simulators.

Demonstrate effi-
ciency of human
visual and vestibular
system models.

Establish task-
related criteria
for specifying
required simulator
capability.

Develop and evalu-
ate operational
digital color display
system for high
fidelity visual
scene generation.

Provide the technical data
base permitting the econom-
ical and reliable substitu-
tion of simulators for actual
flight operations in aeronau-
tical research, development,
and pilot training.

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	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>Comments</u>
Knowledge of Atmospheric Processes	Complete data collection for ground wind profile model development. Complete computer modeling of fog modification processes.	Complete oc/air spallation products reaction description. Complete mountain wave optical radar experiments. Complete haze nuclear counter development. Complete laboratory fog chamber studies. Complete assessment of RPV storm penetration feasibility.	Complete data collection for ABL model development.	Investigate & describe cosmic radiation hazards to civil aircraft operations at high altitude. Complete optical radar and laser Doppler CAT ground experiments.	Determine the feasibility of airport pollution predictive models for practicable use. Complete fog-dry air experiments.	Investigate & define the mechanisms by which warm fog is formed and dispersed. Need for design data on atmospheric processes which directly affect the safe and efficient operation of aircraft designs.	
Aviation Safety Research and Technology	Complete description of the runway surface interface. Complete VGH survey & analysis of current general aviation aircraft.	Identify high potential approach & landing accident causes. Describe fuel-fire mechanisms & identify candidate research programs for reduction of fuel-fire likelihood.	Identify high potential take-off and cruise accident causes. Complete examination of laser Doppler detection avoidance concepts for wake & clear air turbulence.	Identify safety hazards of unconventional surface effect landing systems & crosswind landing gear systems. Complete flight tests of visible wake vortex marking systems. Complete new aircraft model ditching tests.		Provide technology basis permitting elimination of cabin interior fires. Provide technology basis for engines employing burst-proof rotor disks. Need for basic research and experimental testing to provide safety technology to reduce accidents and loss of life.	
Aircraft Systems Operational Efficiency Improvement	Recap 12 aircraft tires with new polyblend material & begin dynamometer tests & FAA certification. Evaluate 6 recapped tires in fleet service. Complete fabrication and dynamometer tests of advanced composite brake materials.	Complete field tests of prototype advanced brake linings. Demonstrate in flight a laser Doppler airspeed system.				To establish new concepts and techniques in aircraft systems design, testing and operation which will permit increased operating efficiencies.	

**Aeronautical
Systems Studies**

**Civil Air Transportation Systems
Studies**

1975

Determine traveler acceptance factors in low-density short-haul system.

Assessment of feasibility, potential, mission requirements, economics, and technology needs of modern airships.

Determine feasibility of large cargo aircraft and alternative means of transporting large or unusual cargo.

**General Aviation
Aircraft Technology Studies
Objective**

Complete a study to evaluate performance and economics of turbofan engine powered light aircraft.

Analyze potential demand for general aviation avionics systems.

**Technology for
Future Military
Aviation
Objective**

Study of impact of laser weapons.

Develop an improved military aircraft synthesis capability to aid in evaluation of preliminary designs.

Evaluate performance and economics of turbofan engine powered light aircraft as basic trainers for military.

1976

1977

1978

1979

1980

Comments

Determine from mission, systems, and conceptual studies, the technology requirements, costs, benefits, and impacts of advanced civil and military aeronautical systems.

To identify significant technology advances and R&T preparation required to support general aviation development in the 1980's.

To identify significant technology advances and R&T preparation required to support expected needs of future military aviation.

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Aeronautical
Systems Studies

Energy Conservation
in Aeronautics
Objective

Determine cost, noise, and fuel conservation trade-offs and technology requirements for long-haul aircraft.

Determine requirements for long-range aircraft using alternative fuels (LH, liquid methane).

Evaluate ability to provide future portable energy needs.

Determine technology requirements of laminar flow control for long-haul subsonic transports.

Analysis Support
for Aeronautical
Planning Objective

Assess potential of alternative approaches (RPV's).

Develop methods of estimating costs of future tilt rotor aircraft.

Analyses of probability of wake vortex encounter.

Prepare road map for aircraft safety R&T base.

Analysis of areas which warrant special consideration on ITT (International Transfer of Technology) in Aeronautics.

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Comments

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1975

To identify promising approaches for reduction of energy consumption of aviation systems.

To provide essential data and analysis for special studies conducted in support of aeronautical program planning activities of OAST.

	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>Comments</u>
Integrated Programs for Aerospace Vehicle Design (IPAD)	Prepare specifications for contractor development of IPAD. Initiate IPAD development contract.			Pre-release a preliminary IPAD system.		General release of an operational IPAD system to U.S. aerospace industry.	Reduce vehicle design cycle time by 50% and design costs by 25% by 1980.
Materials in Advanced Turbine Engines (MATE)			Demonstrate directionally solidified eutectic alloy turbine blades.	Demonstrate advanced composite material fan blades with a 25% increase in strength/density ratio.	Demonstrate powder metallurgy turbine disks with 100° C increase in temperature capability or a reduction in cost. Demonstrate oxide-dispersion strengthened alloy turbine vanes.	Demonstrate ceramic turbine vanes for short-life service.	MATE programs to demonstrate potential of new high technology materials for advanced turbine engines.
Active Control Aircraft Flight Experiments		Complete conceptual design studies and select high payoff active control configurations and determine possible fuel savings.	Derive and validate aerodynamic and aeroelastic models for the selected configuration.	Determine ACA design procedures by carrying two of the conceptual design studies through a preliminary design.			Confirm ACA integrated design procedures and benefits through flight test of remotely piloted active control research aircraft and demonstrate the resultant fuel savings.
				Complete flight validation of selected active control functions on a representative STOL transport.		Complete flight validation of selected active control functions on a subsonic transport during terminal area operations.	

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**Supersonic Cruise
Aircraft Research**

**SCAR Structures
and Materials
Technology**

Comments

1980

1979

1978

1977

1976

1975

Research in support of
supersonic cruise
aircraft.

Complete structural
concept study of
high performance
arrow-wing super-
sonic cruise con-
figuration.

Measure high alti-
tude turbulence
environment with
B-57 aircraft.

Achieve 10,000 hrs.
cumulative exposure
on sample fiber-
matrix composites.

**SCAR Stratospheric
Emission Impact**

Evaluate results of
background and
emission tests with
YF-12.

Complete prototype
of LaRC tunable
laser for sensing
of jet wake.

Demonstrate newly
developed instru-
mentation by flight
tests.

Evaluate background
and emissions data
obtained from flight
tests with newly
developed instru-
mentation.

To develop an understanding
of interactions of the jet
wake on the stratosphere
and to provide remote sens-
ing devices to assess any
environmental changes.

A-24

**SCAR Propulsion
Technology**

Establish noise
reduction potential
of suppressors for
coannular jets for
application to duct-
heating turbofan
cycle engines.

Initiate wind-tunnel
tests of inlet shock
stabilization valve.

Initiate studies of
augmentor pollu-
tion.

Verify potential
of NOx reductions
to 90% less than
current engines at
supersonic cruise
altitudes.

Verify inlet shock
stabilization valve
concept operational
suitability by YF-12
flight tests.

Synthesize and apply
an integrated propul-
sion control system
to the YF-12.

Results of research may
provide background data
which will lead to quieter,
cleaner and more efficient
propulsion systems.

**SCAR Aerodynamic
Performance
Technology**

Complete study of
sonic boom
phenomena.

Extend contracts for
improved super-
sonic loads and
low-speed theory.

Complete transonic
tests of arrow-wing
propulsion and pres-
sure distribution
model.

30% increase in L/D
over present state-of-
the-art for aero-
dynamic configura-
tions.

Verification of
theoretical methods
for rapid analysis
of critical design
loads.

Validation of low-
speed high-lift
aerodynamic perfor-
mance theories.

40% reduction in sonic boom
during cruise conditions
potentially applicable to
far-term advances in super-
sonic transport designs by
FY 1981.

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Supersonic Cruise Aircraft Research

SCAR Stability & Controls Technology

Establish preliminary handling qualities & control mechanization criteria.

YF-12 flight tests of longitudinal cooperative control system.

YF-12 flight tests of lateral cooperative control system.

Apply FLEX STAB to a complete aerodynamic supersonic transport configuration to calculate steady & dynamic stability derivatives & aerodynamic loads.

To establish an expanded supersonic stability and controls technology base which will provide major control systems advances applicable to aircraft operating at supersonic cruise speeds.

Quiet Propulsive Lift Technology

AMST Prototype Aircraft

Obtain flight verification of the de-tailed performance predicted by NASA ground based research data for USB & EBF propulsive-lift aircraft.

Initiate NASA-led flight research using AMST aircraft.

Flight testing of the AMST prototypes which aircraft may be used for NASA's quiet propulsive-lift research airplane.

Quiet Short-Haul Research Aircraft (QSRA)

Contract award for engines for modified research airplane.

Contract award for design, fabrication of hardware & modifications for research airplane.

Initiate NASA quiet propulsive-lift flight research program.

Initiate quiet propulsive-lift research results available.

Technology data base available for use in establishing design criteria & development of civil commercial aircraft.

To establish realistic criteria for certification of commercial subsonic propulsive-lift transport aircraft.

General Aviation Low-Cost Avionics Systems

Complete system & initiate component testing & laboratory simulation of control & display concepts.

Select transponder, data link & navigation concepts.

Complete laboratory simulation & start integrated system design.

Start piloted simulation tests of selected components & subsystems.

Complete piloted simulation tests of breadboard integrated system.

Complete design & breadboard of a low-cost integrated avionics guidance, control & navigation system.

To transfer avionics technology to practical low-cost integrated systems for general aviation aircraft.

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	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>Comments</u>
Noise Reduction Flight Procedures Experiments		Demonstrate potential of other operating techniques for reducing aerodynamic & propulsion noise on approach & landing.					Reduce 90 EPMdB approach noise footprint by at least 60% through scheduled airlines' demonstrations of avionics systems for noise abatement flight procedures.
Terminal Configured Vehicle Operating Systems Experiments		Precision 4-D flight path control. Steeper, curved, & decelerating landing approach. Reduction of impact of aircraft on the environment in terms of aircraft noise & air pollutions. Guidance & control capability for reduction in separation between aircraft on landing approach from 3.65 to 1.62 miles.	Automatic landings in zero visibility. Landing rates in IFR which approach VFR rates. Reduction in runway occupancy from 55 to 25 sec.	Avionics which interface with an advanced ATC system.	Greater safety. Improved productivity by minimizing terminal area delays.		Identify & provide technology for advanced CTOL & RTOL aircraft for reducing approach & landing accidents, reducing weather minimal, increasing air traffic controller productivity, saving fuel, & reducing noise during the 1976-2000 time period.
STOL Operating Systems Experiments		Initiation of Microwave Landing System (MLS) validation flight experiments.	Flight validation of WK model prototype system completed.				Establish technology base for STOL short-haul systems in 1978-2000 time period.
VTOL Operating Systems Experiments	Integrated digital avionics research system available for VTOL research aircraft.	Demonstrate precise time of arrival (4-D) automatic approach & landing.	Conduct simulation in a tilt-rotor research VTOL aircraft.	Demonstrate automatic operational guidance capability at unimproved & shipboard landing sites. Demonstrate automatic optimal approach & landing trajectories in both helicopters & other VTOL aircraft, CL-84 & tilt-rotor.			VTOL aircraft technology for improved operational capability and operational efficiency.

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Comments

Provide technology to obtain 75% reduction in noise footprint area of JT8D-powered aircraft.

Design, build & test experimental engines for quiet, clean & efficient propulsion systems.

To insure needed technology on all major components of engine available for advanced transport engines in mid-1980's.

To provide proof-of-concept of supercritical airfoil technology in the transonic & low supersonic flight regimes.

1980

1979

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Demonstrate objective of 75% noise reduction with re-fanned engines & 727 aircraft nacelles by ground tests of actual flight tests of a DC-9 aircraft.

Final economic & performance data to FAA.

Delivery of first engine to LERC for in-house testing in an under-the-wing configuration.

Delivery of second engine in an over-the-wing configuration.

Performance test complete.

Final design, fabrication & assembly complete.

Initiate a hardware phase with one contraction.

Initiate program definition preliminary design contracted efforts.

Establish improvements 100% increase in buffet onset, better than 50% reduction in profile drag, 17% increase in Mach divergence in Mach 0.85 to 0.95. In-drag & 5000 ft. increase in optimum cruise altitude.

TACT flight experiment applicable to variable sweep commercial vehicles & interceptors.

Experimental Propulsion Refan Program

Quiet, Clean, Short-Haul Experimental Engine (OCSEE)

A-27

Advanced Multi-Stage Axial Flow Compressor

Flight Experiments
Transonic Aircraft Technology

Comments

1980

1979

1978

1977

1976

1975

Fly-By-Wire
Flight Experiment

Start flight test
of all digital
systems.

Complete flight
tests and advanced
flight control law
validations.

The AFBW Program conducted
to make technology avail-
able to designers in the
late 1970's.

XF-12 Flight
Experiments

Complete dynamic
measurements.

Final reporting of
inlet performance
& dynamics.

High-speed flight
& corresponding
ground measurements
of boundary layer
transition, noise,
heat transfer, &
skin friction com-
parisons & analyses
will be completed.

In-flight support of
ground-based re-
search in the areas
of stability & con-
trol, propulsion,
structures, & ma-
terials.

Assess current analytic
and experimental tech-
niques in design of super-
sonic cruise aircraft.

A-28

Composite Struc-
tures Flight
Experiments

Complete 3 years of
flight service demon-
stration of an 1170
weight saving on 2
selective composite
reinforced center-
wing boxes on C-130
aircraft.

Demonstrate a 25% weight
saving in a vertical fin or
horizontal tail primary
structure component of a
commercial civil transport
using graphite epoxy com-
posites and accumulating
20,000 flight hours by
1985.

Wake Vortex
Minimization
Flight Research

Complete modifica-
tion & instrumen-
tation of existing
NASA generating &
probe aircraft,
respectively.

Initiate final flight
demonstration of
most effective alle-
viation devices with
wide-body jet trans-
port.

30% weight saving in a wing-
box primary structure 10,000
flight hours.

Develop a flight research
capability which will reduce
the landing separation dis-
tance imposed by wake
vortices from 3-5 miles to
2 miles.

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	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>Comments</u>
C-8 Augmentor Wing Flight Experiment	Definitive criteria for control of flight path & airspeed & for roll & yaw power for powered-lift transports through flight confirmation & refinement of studies & experiments.		Confirm & extend certification criteria for powered-lift aircraft developed through piloted simulation.				Validate in flight the augmentor-wing powered-lift concept as a practical means for providing short take-off & landing capability.
Advanced Acoustic Composite Nacelle Flight Program	Development of flight director laws & integrated controls.	Complete nacelle concept definition studies & verify approach.			Complete ground tests of an advanced technology nacelle.		Demonstrate quiet nacelle performance in routine airline service by 1982.
Rotor Systems for RSRA	Initial selection of rotor systems.	Begin design & fabrication of second rotor system.		Flight tests of rotor system.			
	Begin design & fabrication of first rotor system.		Ground tests of rotor system.		Certify an advanced nacelle for airline service on a wide-body transport.		
Rotor Systems Research Aircraft	Fabricate two rotor systems research aircraft.	Aircraft delivery to Government.	Initiate NASA/Army rotor research program.				Evaluate an unique flight test capability in 1976 for advanced rotor research of new rotor concepts.
	Initiate contractor flight test.						
Tilt Rotor Research Aircraft	Fabricate two tilt rotor aircraft.	Complete ground testing.	Definitize advanced flight research program.				
		Start flight research.					
Highly Maneuverable Aircraft Technology (HIMAT) Flight Research Program	Exploit RPRV concept to provide vehicles at 50% less than comparable manned vehicles.						
	Demonstrate a "Time-on-Advantage" ratio.						
	Provide a sustained turn capability at 8 g's in the transonic speed regime.						